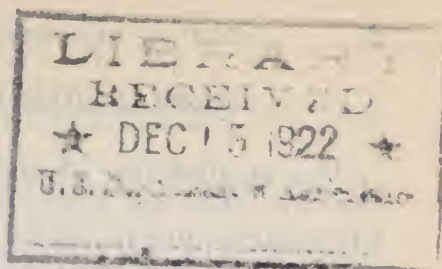


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REPORT OF THE CHEMIST.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF CHEMISTRY,
Washington, D. C., September 16, 1922.

SIR: I submit herewith the report of the work of the Bureau of Chemistry for the fiscal year ended June 30, 1922, and recommend that it be printed in the usual manner.

Respectfully,

W. G. CAMPBELL, *Acting Chief.*

HON. HENRY C. WALLACE,
Secretary of Agriculture.

INTRODUCTION.

The activities of the Bureau of Chemistry may be classified for easy consideration into three broad groups which, although fairly well defined, are so closely correlated in some instances that there is no distinct line of demarcation; but rather a merging or supplementing of the activities in the one group by those in the other two. These three groups may be designated (1) research in agricultural chemistry; (2) the application of chemistry to production and the utilization of agricultural products—that is, agricultural chemical technology; (3) the enforcement of certain regulatory statutes which frequently either gives form to the results obtained in the other two groups or influences the activities of those groups by revealing problems which it is their function to solve.

The fiscal year 1922 has been one of stock taking and realignment of certain activities, especially in Groups 1 and 2, one of those occasional but exceedingly important readjustment periods which come in the life of every healthy, progressive organization when the evidence obtained from preliminary work in a particular field indicates the probability of obtaining immediate worth-while results so clearly as to dictate an administrative policy of concentration of effort and even a brigading of otherwise independent units to accomplish the desired results. However, where funds are limited this must of necessity curtail activities in some already established lines of work or postpone active consideration of contemplated, and perhaps equally as important, lines of work.

In Group 3 the fiscal year 1922 marked the complete installation of a system for handling the work in connection with the enforcement of the Federal food and drugs act on a project basis, which enables all units of the organization to work in unison toward a common end with the minimum expenditure of time and funds.

RESEARCHES IN AGRICULTURAL CHEMISTRY.

The application of chemistry to agriculture in the most comprehensive sense has been one of the chief functions of the Bureau of Chemistry since its establishment, although in recent years this phase of the work has received less public attention than the work on the enforcement of the food and drugs act. The food work, however, is an outgrowth of investigations into the composition of foods conducted originally as a chemical agricultural study. While the practical application of the results of research is not always apparent for a considerable period after the researches are completed, the basic studies in agricultural chemistry have led to results of the greatest practical importance. Processes for the greater utilization of farm crops and production by-products have been developed and improved and new manufacturing industries established, work more fully outlined in another part of this report.

ODOROUS CONSTITUENTS OF FRUITS.

Investigations pertaining to the odorous constituents of certain fruits, particularly the apple and the peach, are in progress. A paper on the odorous constituents of the peach was published during the year. A patent for the preparation of a synthetic apple oil has been granted as the result of these researches. A paper describing the results of a further investigation on the apple odor has been prepared for publication, and also one on the presence of methylantranilate in grape juices.

STUDIES ON VEGETABLE OILS.

The economic importance of a further utilization of vegetable oils and of the production of oils from sources not now available has led the bureau to make a systematic study of the chemical composition of vegetable oils. These studies include investigations to determine the physical and chemical characteristics of the principal commercial vegetable oils, especially those produced from oil seeds grown in this country. The chief vegetable oils manufactured in the United States include castor, coconut, corn, cotton seed, linseed, mustard seed, olive, palm kernel, peanut, raisin seed, rapeseed, sesame, and soy bean.

During the year investigations on the composition of sunflower-seed oil and soya-bean oil have been completed and the results prepared for publication. Work on the determination and identification of the constituents of crude cottonseed oil is under way. Considerable progress has been made in the separation of the free fatty acids occurring in the commercial crude cottonseed oil, and a study is being made of the composition of these acids, as no data are available which give this information needed by the oil industry. Work on the method for determining the total amount of neutral glycerides in a crude vegetable oil has been completed and the results published. This is the first time in the history of the great cottonseed industry that a method has, upon investigation, been found applicable to determine the neutral oil present in a crude vegetable oil. Researches of this character, which will show how to reduce the refining loss,

are of indirect benefit to the cotton growers, since the price paid by the refiner for crude oil may be greater.

Results of analyses of authentic peanut oils were published during the year.

Past results from research conducted elsewhere on cottonseed oil, making it possible to utilize profitably cotton seed, which was considered until comparatively recently practically a waste, indicate the possibilities of further research on vegetable oils.

STOCK FOOD INVESTIGATIONS.

Investigations are in progress on the utilization of waste products as cattle feeds. A bulletin has been prepared upon the use of apple pomace and apple pectin pulp. The work on this subject involved a large number of laboratory determinations and large-scale feeding tests of the pulp, in cooperation with the Bureau of Animal Industry experiment station at Beltsville, Md.

To help other bureaus of the department solve problems in which the composition of cattle feeds and grains is a factor, many analyses are made of samples submitted and the results reported to them. During the year 158 samples were examined for the Bureau of Markets and Crop Estimates, 1 for the States Relations Service, 72 for the Bureau of Plant Industry, 19 for the Bureau of Animal Industry, and 81 for the Forest Service. In addition, 2 were examined for the War Department and 31 for the Panama Canal Commission. These analyses are of great value in establishing specifications and controlling purchases.

A study has been made of the various portions of the kernels of grain sorghums in order to determine the suitability of grain sorghums for feed and for milling purposes. The results are reported in a bulletin in course of publication on the composition of feterita and milo.

In cooperation with the Bureau of Markets and Crop Estimates, a study was completed on cotton seed and its products, the object being to determine the quality of cotton seed in different sections of the country as a basis for practical standards and for a better understanding of the composition of cotton seed as affected by the locality in which it is grown and the variation in composition during the season. The results are given in Department Bulletin No. 948, entitled "Composition of Cotton Seed," which was published during the year.

CROP CHEMISTRY INVESTIGATIONS.

A laboratory of crop chemistry has been recently established in order to systematize and extend the work in this most important agricultural field. Studies will be undertaken on the composition of agricultural crops in a fundamental way. Steps are being taken to collect, critically digest, and summarize existing data in order that gaps may be filled in our knowledge thus brought to light. Additional work will be carried on concerning the influence of environment on the chemical composition of crops, including certain features of fertilization, such as the relation of chemical composition and food value of crops to the time of fertilizer application.

Past work on the composition of agricultural crops has been directed chiefly toward what may be termed the quantity viewpoint. This new work will be directed more toward the subject of quality. For instance, it is known that the application of a certain fertilizer, say, sodium nitrate, at a definite time, as one month after sowing, to a crop like corn will increase the yield quantitatively. However, practically nothing is known about quality relations; that is, whether the proteins, vitamins, or mineral components of the corn fertilized in such a way are better suited to animal and human nutrition than those of unfertilized corn. Varietal differences will be studied from a chemical viewpoint. For instance, it will be determined if there are any fundamental chemical differences in the composition of flint or hard corn and the dent corn largely produced in the United States, in an endeavor to determine the reason for the preference of the European countries for Argentine or flint corn to corn produced in the United States.

PROTEIN INVESTIGATIONS.

One of the most important researches now under way is that upon vegetable proteins. Inasmuch as nitrogen is an essential part of animal tissues and the animal can obtain this necessary nitrogen only in the form of protein in its feed, it is obvious that this class of feeds is of prime importance. This research involves the very existence of all animals and is inseparably connected with the field of nutrition.

Until quite recently one kind of protein in a diet was considered as good as another. To-day we know that one protein differs from another protein in certain fundamental constituents called amino acids, of which all proteins are composed. Some of the amino acids are absolutely essential for nutrition, for without them animals will not grow, but will soon fail and die. The protein of corn is deficient in two essential amino acids, tryptophane and lysine. A young animal on a diet having its sole source of protein derived from whole corn will not grow and develop properly. However, if the protein of corn is supplemented by the addition in the right proportion of certain other proteins, the protein of the mixture will then be adequate for normal growth. From this it follows that an exact knowledge of the chemical composition of the different proteins in feeds is necessary. It is essential not only to know whether in themselves they are adequate for the needs of the animal but also to know when they are deficient, what other proteins, and in what proportion, must be added to supplement the deficiency. The percentage of nitrogen alone can not therefore any longer be regarded as an index of the protein value of a feeding stuff.

The amino acids of the proteins of several agricultural products have been separated and studied, with the result that it is now possible to supplement such basic feeding stuffs as corn with small quantities of other feeds, such as peanut meal, soy-bean meal, and coconut press cake, which contain the very amino acids corn lacks, thus making a feed that will supply all the amino acids necessary for growth. The practical results of this should be a greater and more profitable utilization of our largest cereal crop, corn.

Work now in progress includes an investigation of the protein of wheat bran. A method by which over 90 per cent of the total protein present in bran may be extracted has been developed and applied. Analyses of these proteins have shown that they are probably of high nutritional quality. The extent to which the protein of bran differs from those of the wheat endosperm will be ascertained.

An investigation of the protein of cotton seed is in progress. Little work has ever been done on this subject, notwithstanding the large and continually increasing extent to which it is used as a feed for farm animals. Since most of the peanut meal offered on the market for feedstuff contains also the shells, it is desirable to have some knowledge regarding the protein in the shells, and studies to this end are under way. A chemical study of the protein of cantaloupe seed is nearing completion. Work on the determination of the amino acids in soy-bean globulins is being continued.

Studies of the nutritive value of the palm-kernel meal were completed. The results show that the proteins of palm-kernel meal are adequate for the promotion of normal growth.

Work on the nutritive value of the proteins of the lentil is in progress. Results of work on the protein of the cowpea and of the field pea have been published during the year. The proteins of the cowpea are limited in their nutritive value by a deficiency of the amino acid cystine, and by an indigestibility which can be remedied by cooking. The protein of the field pea, and that of the cooked cowpea, plus cystine, were equally efficient in promoting growth at a practically normal rate, while the protein of the cowpea, raw with cystine added, or cooked without cystine, was less than half as well utilized as those of the field pea.

Results of research on the protein of the tomato seed have been published. Over 2,000 tons of tomato seed are annually discarded as a by-product in the tomato-pulping industry. These studies show that by utilization of this by-product for feeding purposes the conservation of a valuable feed can be accomplished. A chemical study of the protein of the lima bean has been completed. Chemically and also biologically the protein of the lima bean is quite similar to that of other beans which are botanically related. They contain adequate amounts of the nutritionally essential amino acids with the exception of cystine, the percentage of which is below the minimum required for the normal growth of animals.

A chemical study of the protein from the navy bean has been completed and a manuscript prepared for publication. A manuscript is being prepared on "The nutritive value of peanut, soy bean, and coconut press cake as supplements to corn." Studies on the proteins of other beans are in progress.

WORK ON INSECTICIDES AND FUNGICIDES.

Studies are being made of the chemical composition and efficiency as a fungicide of Pickering Bordeaux mixture to ascertain whether Pickering formulas can be applied under American field conditions so as to accomplish effective control of fungi diseases. The ultimate object of the study is to use Pickering Bordeaux instead of standard Bordeaux if it is possible, since Pickering Bordeaux contains much less copper than standard Bordeaux and is, therefore, very much

cheaper. Experiments in northern Maine indicate that Pickering sprays exert the same stimulating action on potato plants and increase in yield to the same extent as standard Bordeaux sprays. A barium copper spray was prepared which possessed some very desirable properties as a fungicide and gave satisfactory results on potatoes. A public patent covering the preparation and use of this product has been obtained.

As a result of investigations of the problems involved in spraying potatoes and other plants with Pickering and other copper sprays, papers were prepared during the year on "Absorption of copper from the soil by potato plants" and on "The influence of copper sprays on the yield and composition of the tuber of the Irish potato."

Chemical and physical studies of insecticides and investigations on the physiological effect on insects of arsenical insecticides and of the materials entering into their composition have been carried on for the past four years in cooperation with the Bureau of Entomology. Some of these results will soon appear in bulletin form under the title "Arsenicals: Chemical, physical, and insecticidal properties."

Investigations in cooperation with the Bureau of Entomology have been carried on in Texas for the purpose of devising methods for the control of screw worm flies and related species which infest live stock, particularly cattle. Several attractants have been discovered, of which dried eggs seem to be the most promising. These when used in connection with traps have been found to be of great value in reducing the number of flies. Several promising repellents have also been found and are being further tested.

An investigation was made to determine the quantity of poisonous elements that may be present on sprayed fruits and vegetables by reason of the excessive use of sprays, and to determine whether changes can be made in the time and method of spraying by which the danger from injurious metals may be eliminated. The results were published in Department Bulletin No. 1027, Poisonous Metals on Sprayed Fruits and Vegetables.

The results of hundreds of fumigations of various grains, vegetables, and other food products with hydrocyanic acid for the purpose of destroying insect pests infesting them are embodied in a manuscript prepared under the title "The absorption of hydrocyanic acid by fumigated food products."

Foliage injury by lead arsenate and other insecticides was studied to determine the action of various impurities in lead arsenate on foliage, and the action of natural water containing various salts on lead arsenate. Investigation was made of the burning properties of various insecticides and fungicides and an effort was made to develop spray materials and mixtures effective as insecticides and fungicides but producing a minimum injury to tender foliage.

Cooperating with the Bureau of Entomology on methods for the control of the Mexican bean beetle in Alabama, a number of lead arsenates and other arsenicals were prepared for trial. The bean plant is particularly susceptible to injury from the application of arsenicals. A satisfactory poison that can be used with safety on bean foliage has not yet been developed. It was found that the

natural waters in certain regions act on lead arsenate, breaking it up and forming soluble compounds that are injurious to the foliage. A number of the waters were analyzed and methods for overcoming this objection were suggested.

Several special calcium arsenates and four nicotine dusting mixtures were prepared for tests on cotton foliage. During the year 1,202 samples were examined to aid other bureaus of the department, especially the Bureaus of Entomology and Plant Industry, in solving problems which required chemical investigations of an insecticidal or fungicidal nature.

Cooperative work with the Bureau of Entomology has been started to make a thorough chemical and physical study of calcium arsenate for the purpose of developing a more satisfactory calcium arsenate for use as a dust application to cotton for the control of the boll weevil.

METHODS OF ANALYSIS.

A portion of the time of the chemists of the bureau was devoted to the development of new and the improvement of old methods of chemical analysis. These methods are published from time to time as they are perfected in the Journal of the Association of Official Agricultural Chemists or in other scientific journals for the use of chemists employed in the agricultural experiment stations and in the industries. The development of methods of analysis is to the chemist what the building of improved roads is to the traveler, enabling him to enter new fields more easily, rapidly, and efficiently. Results obtained in different investigations in widely separated fields of activity are comparable only when standardized methods have been used.

Agricultural chemists in the experiment stations and colleges cooperate in the development of methods of analysis. While the immediate results of this work are of interest only to chemists, the ultimate results are reflected in an improved agriculture and in the development or improvement of industrial processes for the utilization of agricultural products.

AGRICULTURAL CHEMICAL TECHNOLOGY.

As a natural outgrowth of the research work in agricultural chemistry, there are in progress a number of projects which have for their primary object the development of manufacturing processes which utilize and provide new outlets for the products and by-products of the farm. This is the practical application of the results of research.

IMPROVEMENTS IN THE MANUFACTURE OF CANE SIRUP.

Marked progress was made during the year in putting into commercial practice the invertase method of making cane sirup to which reference has been made in previous reports. Several cane-sirup makers used the new process during the last season with excellent results. A cane sirup which would not readily crystallize or ferment was for the first time placed upon the market in considerable quantities.

Attention is now being given to the production of a cane sirup of uniform standard quality. This work promises to be of the greatest economic importance to the cane-producing States.

A more extensive market for cane sirup is of great importance in the agricultural scheme of a large area of the South. In many sections cotton can no longer be profitably produced on account of ravages of the boll weevil. It is necessary to adopt a more diversified scheme of agriculture, and sugar cane is one of the crops upon which greater reliance should be placed. It is one of the surest crops which can be grown in this region. The harvesting and production of cane sirup come at a time of the year when the farm labor can be used very advantageously for that purpose. There is ample evidence that the farmers of the South are greatly desirous of increasing their acreage of sugar cane. This is not possible, however, unless a more adequate market is developed for cane sirup. This market can not be extended unless cane sirup of uniform and satisfactory grade can be consistently produced. This, in turn, depends upon the successful working out of certain chemical and technological problems. These problems are therefore the key to the entire situation.

It is planned under this project to continue the work started last year and to study systematically all factors which are involved in the production of high-grade cane sirup of uniform quality and to work out all corrective measures which it is necessary to apply to present practice in order to accomplish this end.

Outside of Louisiana, sugar cane is grown solely for production of cane sirup. This is the sole manner of utilization, since the sirup is not of sufficient purity to be utilized in the manufacture of sugar. The value of sugar cane as an agricultural crop is, therefore, dependent solely upon an adequate market for cane sirup. Extension of the market beyond a local one has been greatly handicapped by the fact that cane sirup as produced by a large number of farmers has varied greatly in quality. The planters need technological assistance and advice in solving this problem.

During the past year the Bureau of Chemistry has received a large number of insistent requests for assistance along this line. The farm bureau federations in various Southern States have organized cooperative cane-sirup associations for the purpose of blending cane sirup on a large scale in central rehandling and canning plants. The bureau has been asked to undertake the solution of chemical and technological problems involved in this plan of operation and work is now under way. These cooperative associations are planning to use the invertase method developed in the bureau for the purpose of producing a sirup which will not crystallize. These associations have also requested that the bureau undertake systematic research work for the purpose of solving all remaining difficulties which stand in the way of producing a uniform cane sirup of highest grade. While a great deal of progress has been made, a number of important points still remain to be worked out on a satisfactory basis. Among these may be mentioned the best manner of treating low-grade sirup, improved method of clarification so as to secure a brilliantly clear sirup free from sediment, use of mechanical filtration, and introduction of vacuum-pan evaporation. In other words,

improved larger scale methods for handling cane sirup have now become possible through the organization of the cooperative cane sirup associations and the operation of central blending plants.

WORK ON SORGHUM SIRUP.

The situation with respect to sorghum sirup is much the same as that of cane sirup, with the exception that cooperative handling and marketing of sorghum sirup have not yet reached so advanced a stage. In the meantime it is desired during the fiscal year 1924 to discover the cause of and find a remedy for "jellied" sorghum sirup. This refers to a gelatinous consistency which sorghum sirup frequently assumes and which causes considerable loss. An improved method of clarification to secure a brilliantly clear sirup is greatly needed in order to increase the marketing possibilities of sorghum sirup, and work is planned to accomplish this. Some difficulty is also experienced from sugaring, and it is planned, when necessary, to apply to sorghum sirup the invertase method originally devised by the Bureau of Chemistry for treatment of cane sirup.

USE OF INVERTASE IN PRODUCTS OTHER THAN CANE SIRUP.

The invertase method was applied during the year to products other than cane sirup. Application has been made for a public patent for its use in a process for the manufacture of a mixture of refiner's sirup and a partially inverted sucrose sirup. The process has been used successfully on a large scale. The invertase process has also been used in the manufacture of a high-density maple sirup and of maple and cane sugar sirup mixtures. Application for a public-service patent to cover this process has been made.

A process was also worked out for preparing a soft cream center, such as is used in chocolate creams and similar types of confectionery. This achieves a result which has for a long time been desired by the candy industry, since the process previously used was not satisfactory. A public-service patent has been applied for to cover the production of an improved maple cream by the use of invertase.

DOMESTIC CANE SUGAR INDUSTRY.

In order to compete with cane sugar from the Tropics, the sugar-cane planters of Louisiana are very greatly in need of improved methods whereby better grades of sugar and molasses can be produced and manufactured more efficiently. Work to this end has been carried on during the past year. Research work along these lines is necessary because sugar cane does not fully mature in Louisiana, so that, since the composition of the juice differs from that of cane grown in the Tropics, special methods of manufacture must be used. The working out of more efficient methods would result in an enormous increase in the value of sugar cane and would be of the greatest constructive assistance to Louisiana cane planters. At the present time the production of sufficiently high-grade molasses is accomplished at the expense of too great a reduction in yield of sugar. The production both of an adequate yield of high-quality sugar and of molasses of acceptable grade is necessary in order to insure a reasonable return for sugar cane.

In addition to developing improved and more economical methods for manufacturing better quality molasses, the problem of utilizing blackstrap molasses most efficiently has been considered. At the present time blackstrap is virtually a waste product, and an increased return for this material would give the cane planter a corresponding profit on his cane delivered at the mill.

BEET-SUGAR INVESTIGATIONS.

The proportion of sugar which can be extracted from sugar beets, as well as the actual sugar content, determines the value of beets to the grower and to the sugar factory. The proportion of sugar originally in the beet which is lost in manufacture results in an enormous loss annually to the beet-sugar industry. A constructive investigation of the factors which determine the proportion of recoverable sugar is just as important to the grower of beets as investigations designed to increase beet production.

Some of these factors which are distinctly chemical in character exert their influence before harvesting while others have an effect after harvesting. One of the most important is that involved in the storage of beets. Outside of California it is necessary, because of the early advent of freezing weather, to store beets in piles for a certain period before working them through the factory. This period averages about 25 days. During storage an average of 0.4 per cent of the sugar in the beets is destroyed daily, or a total of about 10 per cent of all the sugar contained in the beets at the time of harvesting.

In addition, among other factors the deteriorative changes which beets undergo during storage cause the introduction into the juice of substances which interfere with crystallization of sugar and reduce the proportion of the remaining sugar finally extracted in the factory. This effect is particularly apparent in the operation of the Steffen process, which is used in this country to desugarize molasses. If this process were as effective elsewhere as it frequently is in California, approximately 95 per cent of the sugar in beet molasses would be recovered, thus greatly increasing the total yield of sugar from beets. Owing to the accumulation of substances which interfere with crystallization of sugar, only about 60 per cent of the sugar in beet molasses produced outside of California is finally extracted. This immense wastage of sugar involves a financial loss to the beet-sugar industry of many millions of dollars per annum.

The cause of this difficulty has been ascertained, as the result of investigations in the bureau, and two methods are being proposed for a practical solution, one depending on corrective measures in the factory and the other on prevention before the beets enter the factory. The entire problem is one of applied agricultural chemistry. In view of the fact that this loss of sugar occurs after the expense for raising and harvesting the crop has been incurred, a reduction in this loss would increase the value of the beets to grower and sugar factory alike and would be of more value to the industry than a corresponding increase in beet production.

The beet-sugar industry occupies an important place in the agricultural scheme of a large area of the United States, and reduction of the sugar losses under discussion is of immense importance to it.

The industry is in a depressed condition at the present time and in certain sections of the country this condition is especially serious. Constructive assistance in the manner outlined would be of very great importance at any time and is particularly needed under present conditions.

FURFURAL FROM CORNCOB AND OTHER WASTE.

The work on the utilization of corncobs, which has been reported previously, has led to further experimentation in the manufacture and utilization of furfural. Heretofore the cost of furfural was too great to permit its general commercial use. It can now be made from corncobs by processes developed in the Bureau of Chemistry at a price that makes its use of interest to a number of manufacturing industries. It can be used, for instance, in the manufacture of synthetic resins which heretofore have been made chiefly from formaldehyde and phenol. The commercial demand for synthetic resin compounds is increasing rapidly, as they are used in the manufacture of printing plates, phonograph records, varnishes, pipe stems, electrical-instrument parts, buttons, binders for brushes, glue, and many other useful articles. In addition to furfural, there have been obtained from corncobs acetic acid and a gummy material which can be used as an adhesive in the manufacture of pasteboard boxes and may prove useful in the manufacture of coal briquettes.

Experiments are under way on the manufacture of furfural from other agricultural wastes, such as rice hulls, buckwheat hulls, cottonseed hulls, and peanut hulls. Peanut hulls yield less than one-third the amount of furfural that would be expected from a comparison of their pentosan content with that of corncobs. The yield with steam alone is so low as to preclude any commercial consideration of the use of peanut hulls as a source of furfural by the process as used for corncobs. There are indications that this yield may be considerably increased by the use of certain catalysts, and the effect of these will be studied.

BEVERAGE FROM CASSINA.

Investigations on a laboratory scale showed that a very delightful beverage resembling tea in many respects can be made from cassina, a wild plant that grows abundantly in the South Atlantic and Gulf States from Virginia to Texas, when the leaves of the plant are treated by processes similar to those used in curing tea. The cassina plant has been used to a limited extent by Indians, and, during the Civil War when tea and coffee could not be obtained, by people of the Southern States, to make a beverage. Unless properly cured, however, cassina does not make a good beverage.

It having been demonstrated in the laboratory that cassina could be treated by processes similar to those used in the tea industry and an excellent beverage made from it, work has been undertaken to produce it on a larger scale. An experimental plant has been installed near Charleston, S. C., and preliminary reports indicate that the laboratory results can be duplicated on a commercial scale.

Laboratory experiments have been conducted on the use of the hot water extract of properly cured cassina leaves as a base in the

production of carbonated beverages. Carbonated bottled beverages of three distinct types have been made in the laboratory from flavoring sirups containing cassina extract. Formulas have been prepared for the manufacture of cassina-flavored bottled sodas.

LEATHER INVESTIGATIONS.

The shoe-wearing experiments, conducted jointly with the War Department, which necessitated the complete analysis of 225 samples of leathers and a great amount of work in calculating, tabulating, and correlating analytical and wear data, have been completed and a report made.

Civilian wearing tests were continued during the past year and many additional data have been thus collected on the wearing qualities of the experimental leathers used in the cooperative service tests.

As a result of trials made with machines designed in the bureau to test the relative wearing quality of sole leathers, necessary modifications and improvements have been suggested and are being made.

A report has been prepared in which the following general conclusions are given: Under the conditions of these tests, bark-tanned upper leather was not as satisfactory as were the other types of upper leather; fiber soles, while showing a very high resistance to wear, were not suitable, mainly because of the development of physical failures during service; oak, chestnut, and hemlock sole leather tannages showed practically the same average wear resistance, while belting leather indicated a slightly greater serviceability; chrome sole leathers outwore the vegetable tannages, with unwaxed chrome showing the highest wear resistance. There was practically no difference in the wear of loaded and unloaded leathers; well-rolled leathers showed about 16 per cent more wear than unrolled ones. Soles from the shoulder end of the bend did not show an average wear equal to those from the butt end. Extensive data on the comparative chemical composition of the original leathers and parts of the worn soles are given.

Results showing the effect of relative humidity on the physical properties of leathers, the first extensive ones on this subject, were presented in a paper read at the annual meeting of the American Leather Chemists' Association. The data aroused considerable interest, since they indicated, at least with leathers of a certain type, that humidity has a decided effect which can not be ignored in the accurate physical testing of leather.

Experiments dealing with the relative preservative effects of various oils and greases on leathers were completed and the results presented in a paper before the American Leather Chemists' Association. These results, while interesting and possibly indicative, were not entirely conclusive, and it is planned to carry on more of such work for confirmatory and additional data.

Farmers' Bulletin No. 1183, *The Care of Leather*, was reissued in revised form. A second revision of Farmers' Bulletin No. 1055, *Country Hides and Skins*, has also been issued.

The following papers were published during the past year: "The effect of atmospheric humidity on the determination of moisture in leather," "Notes on water extraction of leather," "Rapid washing

of chromed hide powder." "The explosiveness of tannery dusts," "The determination of Epsom salts in leather," and "Extraction of oils and greases from leather."

TANNING ON THE FARM.

In response to the numerous inquiries received daily on methods for home tanning, work on small-scale tanning was conducted to the fullest extent possible under the conditions and means available. Some very satisfactory leather was made in the laboratory, both by the chrome-tanning process and with vegetable tanning extracts, and experiments were also made on tanning fur skins and hides with the hair on. Detailed directions were prepared on making chrome-tanned leather and bark-tanned sole and harness leathers on a small scale, and about 6,000 copies of these directions were sent out in mimeographed form, together with the directions for making alum-tanned leather for belt lacings which were prepared last year. The demand for information on home tanning has continued to increase so that it has been necessary to submit the information so far available for publication as a department circular.

METHODS FOR MAKING LONGER LASTING LEATHERS.

The limited work under way in this bureau on leather should be expanded into a broad project on tanning materials, tanning, and leather. Agriculture produces the raw materials and uses more of the finished products than does any other industry. Work of great economic and practical importance needs to be done. The total number of hides and skins used in making leather in this country in 1914 was more than 140,000,000, costing the tanners, it is estimated, \$240,000,000 plus \$45,000,000 worth of tanning, currying, and finishing materials. The factory value of leather goods made from these materials is estimated at more than \$650,000,000 for which the ultimate user probably paid at least \$1,000,000,000. It is well known that there are large preventable losses in the handling and use of hides and tanning and finishing materials, and that the quality and kind of finished leather and leather products and the processes involved can be much improved.

There is need for better and more durable leathers and for knowledge of how to make, test, and recognize them. Better methods of tanning should materially reduce the cost of shoes and harness to the farmer. Country butchers and farmers now supply about 30 per cent of the hides and skins used in this country. Carelessness, lack of knowledge of taking off, curing and selling these hides and skins cause the loss of about one-third of the value to the farmer. These losses are at least \$15,000,000 annually. The proper handling of country domestic hides and skins would materially decrease the quantity imported. The long-used vegetable tanning materials, which are direct products of the forest and the farm, are totally inadequate under present conditions to supply the country's needs. Others should be sought and developed. Through better processes and more intelligent care many millions of dollars can be conserved annually in leather goods. As important as these materials now are

to agriculture, they will be much more important as population increases and the domestic supplies are actually and proportionately less.

RECOVERY AND UTILIZATION OF WOOL-SCOURING WASTES.

Work on the utilization of wool-scouring wastes was continued during the year. The routine analytical work on representative wool samples which was necessary to supplement the fragmentary information available as to the nonfibrous constituents of raw wools from various sources was finished early in the year, completing the data on more than 300 samples of all grades and varieties.

Work was continued on the economical recovery and utilization of potash from wool wash waters and an experimental wool-washing machine has been built to try out a process for removing the potash from wool prior to the regular scouring operation for removal of grease, whereby the potash is obtained in a solution of such concentration that it can be used in preparing mixed fertilizers with little or no further concentration. In collaboration with manufacturers, mixed fertilizers have been prepared on an experimental commercial scale from concentrated wool wash water, acid phosphate, and leather scrap which were found by laboratory examination and analysis to be of good grade and which, in pot tests made by the Bureau of Plant Industry, proved to be satisfactory for promoting the growth of wheat. Samples of both domestic and foreign wool-scouring wastes have been analyzed for comparison of their content of potash and other fertilizer materials. Work on the recovery of potash from the water effluent discharged from the centrifuges of a commercial wool plant indicated that, while the remaining grease and most of the organic matter could be removed by treating the warm liquor with sulphuric acid, ferric sulphate, or preferably calcium chloride and filtering, it was not practicable to recover potash from the treated effluent because of the high cost of concentration.

In cooperation with manufacturers using the solvent scouring process for removing the grease from wool, considerable work has been done on improving the quality of grease obtained from the extracts. It was found that the quality of grease that can be made depends upon the grade of wool that has been extracted. With the improved treatment developed in the laboratory it was possible to obtain an excellent grade of neutral, ashless grease, which was really a good grade of anhydrous lanolin, from solvents used in extracting wools of certain grades.

Work has also been done on the purification of commercially produced wool greases, and in this connection numerous centrifugal and acid-cracked greases have been examined according to the methods devised in the laboratory. The results obtained indicate that while centrifuged greases may be purified and converted into anhydrous lanolin at a reasonable cost, it is impracticable to attempt any further purification of acid-cracked greases.

In cooperation with commercial wool-scouring mills, work has been done on samples of by-products, including scouring liquors from first and second bowls, sediment from scouring bowls, sludge removed from acid-cracking tanks, and filter press cake. A series of experiments has been started to determine the difference between raw wool

and scoured wool as regards moisture content under various conditions of temperature and humidity. A paper on "Wool-scouring wastes for fertilizer purposes" was published during the year. Both the direct and indirect results of work of this character are to increase the value of a raw agricultural product after it has been produced, increasing the profit to the producer and lowering the cost to the consumer.

NAVAL STORES INVESTIGATIONS.

Turpentine and rosin are among the world's important farm and forest crops, and of the total this country produces approximately 70 per cent. Several millions of dollars can be saved annually to the producer through research and demonstration work. The crop is peculiar in that it is grown and gathered in the eight southernmost States, but practically all of it is used north of the Ohio and east of the Mississippi rivers or is exported. The producers have not the facilities or the means of solving the many problems that arise.

As a result of an investigation during the year on methods for producing rosin esters for varnish manufacture, discovery was made of the fact that when zinc or a zinc compound is used as catalyst, rosin and glycerin can be made to combine more easily and more rapidly than was heretofore possible, yielding a product of low acid number and light color. A public-service patent covering this process was obtained. Several varnish manufacturers have cooperated by preparing batches of varnish from samples of rosin ester made in this laboratory and subjecting these varnishes to wear and weathering tests, which are still in progress. Small quantities of complex compounds made from turpentine and sulphur and from turpentine and oxalic acid were prepared to determine whether they could be used in connection with the work on waterproofing of fabrics.

Investigations on the chemical properties of turpentine and rosin have been continued. To determine whether any differences other than color exist between the various grades and varieties of rosin, analyses were made of authentic samples originating at various points in the producing sections. It was found that there is a difference, although not a very marked one, between the chemical properties or constants of light-colored rosins and those of dark-colored rosins.

Incidental to this investigation it was found that the constants of rosin change appreciably and rapidly on standing after being powdered. A sample of rosin produced about 50 years ago was found to have an abnormal tendency to crystallize, crystalline rosin acids being readily obtained from solutions in alcohol. A number of authentic samples of wood rosin examined differed from gum rosin, not only in having a lower melting point but also in having lower saponification, acid, and iodine numbers, and containing more unsaponifiable matter. Several samples of foreign rosins were also examined. Examination of old turpentine samples disclosed the fact that they had developed marked acidity and had a decided solvent effect on iron, zinc, and copper. Several samples of so-called "recovered turpentine" were found to contain oxidized and chlorinated bodies, in addition to the usual turpentine constituents, and were identified as a by-product from the manufacture of synthetic camphor.

In the investigation of analytical methods applicable to turpentine and rosin, a method for detecting and approximately estimating the quantity of coal-tar adulterants in turpentine was devised and published. A study was made of the effects of various solvents upon the results obtained in determining acid and saponification numbers of rosin esters and similar bodies containing metallic resins. An electrically heated instrument was devised for use in shaping and resurfacing the faces of rosin samples so as to facilitate more accurate grading.

Examinations of 55 samples of turpentine from small paint and general merchandise stores throughout the East showed that the practice of selling adulterated turpentine or mineral oil substitute for pure turpentine is still quite prevalent. In most cases from 10 to 20 per cent of the samples from any locality were found to be adulterated. Regrading in the laboratory of about 1,200 sample cubes of rosin, representing shipments totaling about 10,000 barrels, showed that most of the various lots represented contained considerable misgraded rosin, in some cases as high as 70 per cent. Many instances of misgrading by two grades or more were found.

Samples of gum collected by representatives of the Forest Service from different species of pine in the Florida National Forest were distilled to ascertain the yield of turpentine and rosin, and tests were made to determine the quality of these products.

Two statistical reports were published during the year, including a preliminary report on production and stocks in the hands of principal consumers for the first half of the 1921 naval stores season, and a report showing stocks of turpentine and rosin held by factors, dealers, and exporters at the ports and principal distributing points of the country on March 31, 1922, the end of the 1921 naval stores year. In order to avoid duplication and because the work could be done more economically and efficiently by technologists working on naval stores problems, this bureau entered into an agreement with the Bureau of the Census regarding the collection and compilation of statistics on production of turpentine and rosin and stocks held at the points of manufacture. Statistical data were collected on the distribution of the world's production, trade, and consumption of turpentine and rosin. Additional data have since been compiled and a paper on the subject has been prepared for publication.

Department Bulletin No. 898, *Turpentine, Its Sources, Properties, Uses, Transportation, and Marketing*, the original edition of which became exhausted soon after publication, was revised and reprinted in September. Department Bulletin No. 1003, *The Distillation of Stumpwood and Logging Waste of Western Yellow Pine*, was published in December. This completes a project which was conducted in cooperation with the University of Idaho for the purpose of determining the value of different species of wood for distillation purposes and the most profitable utilization of stumps and other wood waste.

Tentative standard types for the four commercial grades of turpentine were prepared. Several sets of these standards, set up for convenient use, have been distributed to State inspectors of naval stores, the chairman of the naval stores committee of the National Paint, Oil, and Varnish Association, and the secretary of the Turpen-

tine and Rosin Producers' Association for use in determining their practicability and permanence. Up to the present time reports have been favorable.

All sets of the standard glass types for rosin were recalled, cleaned, checked against the master set held in the laboratory, and returned to their several depositories for the use of the trade. The use of these standards is becoming more general and is serving a most useful purpose.

WATERPROOFING AND FIREPROOFING FABRICS.

The weathering experiments started in 1921, which were designed to show the effects on the strength and water resistance of cotton duck exposed to weather when various pigments with formulas previously devised in the laboratory are incorporated, were completed, and a paper giving the results has been prepared for publication. In general, it has been found that the addition of pigments to waterproofing preparations is beneficial since they reduce the injurious effects of solar light and heat without reducing the water resistance.

A paper on "The water resistance of treated canvas during continuous exposure to weather," which embodies a thorough study of the water resistance of 18 waterproofing treatments developed in the laboratory, was published, and one on "The effects of waterproofing materials upon the tensile strength of cotton yarn" was presented at the September meeting of the American Chemical Society.

In response to a number of inquiries concerning treatments which might be suitable for making "glass cloth" from cotton sheeting for covering hotbeds and cold frames, experiments have been conducted and four treatments are now being subjected to a service test. Work has also been done with the object of simplifying the preparation and application of cuprammonium solution to fabrics to such an extent that this might be done on the farm, since the cuprammonium treatment gives greater mildew resistance than any other treatment known at the present time. Tests have been made on the waterproofing qualities of various materials, including complex compounds made from turpentine. Investigations are in progress for the purpose of increasing the life of tobacco shade cloth, which it is estimated costs the tobacco growers \$3,000,000 annually. It is hoped to double the life of the cloth.

MANUFACTURE OF INSECTICIDES.

Work is in progress to determine cheap and effective methods of preparing insecticides and fungicides on a commercial scale, in addition to the chemical investigations on insecticides elsewhere reported. New, efficient, and cheaper insecticides must be found if agricultural workers are to combat successfully or finally exterminate some of the pests most destructive to farm crops. This work includes studies of the properties of commercial insecticides, and during the year progress was made in determining the rate of deterioration in certain materials.

The investigation to determine the rate of deterioration of bleaching powder shows that the rate of deterioration depends mainly upon

the temperature at which the material is stored and the type of container. Before publishing any of the results it is intended to repeat the work on samples packed under Government supervision.

Work on the rate of deterioration of nicotine solutions and nicotine dusts of various strengths, packed and stored under different conditions, shows that nicotine solutions and certain types of nicotine dusts deteriorate very slowly when packed in tight containers. Nicotine dusts containing calcium hydrate or carbonate lose strength more rapidly than dusts made up with clay, Kieselguhr, and sulphur.

An investigation has recently been begun to develop an insecticide for use in the control of insects infesting grains in storage and in transit, to take the place of carbon disulphide, the use of which has been prohibited by the railroads. This work is being carried on in cooperation with the Bureau of Entomology. The investigation has not progressed far enough to reach definite conclusions, but some very promising results are being obtained.

The investigation begun two years ago to determine what chemical changes calcium arsenate undergoes during storage has been completed and the results are in process of publication as a department bulletin under the title "Chemical changes in calcium arsenate during storage." This work was taken up as a result of the belief by certain manufacturers and users of this product that it deteriorated rapidly and was unfit for use after standing for a few months. Results of much interest and value have been obtained. They show that carbon dioxide is very slowly absorbed by the calcium arsenate (or by the calcium hydrate which is present in commercial calcium arsenates) when kept in certain types of commercial containers, resulting in a slow gradual increase in water soluble arsenic, which reaches a maximum after about 8 months in the case of the most open containers, such as sugar barrels. Material packed in tight containers, such as metal drums or heavy hardwood barrels, showed practically no change after 20 months' storage. In a few cases where calcium arsenate was stored in veneer drums and sugar barrels, the deterioration at the end of 20 months was such as to render the material of doubtful safety for application on certain plants having tender foliage.

An investigation is being made of the properties of oil emulsions with the object of assisting the manufacturer or grower to make cheaper and more satisfactory emulsions. The value of this work is self-evident when it is considered that large amounts of oil sprays are used each year, particularly on citrus fruits, and that at present these are often unstable and cause damage to the trees.

A paper, "Errors caused by nitrates and nitrites in the determination of arsenic by the distillation method and a means for their prevention," was also published.

PREVENTION OF PLANT DUST EXPLOSIONS AND COTTON GIN FIRES.

Investigations by the Bureau of Chemistry have shown that the dust that is produced in the handling and milling of grain of all kinds, when mixed with air in proper proportions, is highly explosive. It forms a mixture similar to the explosive mixtures of gas and gasoline. A large number of disastrous explosions have occurred in the thrashing and milling of grain, resulting in extensive losses

to life and property. In 13 recent dust explosions in the United States and Canada, 154 lives have been lost, over 200 people have been injured, and grain and property, valued at more than \$16,250,000, have been destroyed. These explosions have occurred in practically every type of plant or manufacturing establishment where explosive dust is created during operating processes. In addition to the explosions in industrial plants, extensive losses have been experienced in grain-thrashing machines and from fires in cotton gins and cotton-oil mills.

The expansion to a larger operating scale, the capacity for increased production, and the development of industry, combined with the introduction of new methods and types of mechanical equipment for grain handling, have resulted in additional dust-explosion hazard.

It is necessary to determine fully the nature and behavior of these dust explosions, the sources of ignition, and circumstances under which they occur, together with methods of prevention, before effective control can be brought about. The bureau has been called upon to assist in determining the causes of a large number of explosions that have occurred in various types of industries, in addition to those occurring in grain-handling plants, and has definitely established the fact that all industries in which these dusts are produced during operating processes are subject to this hazard. The largest losses at the present time are occurring in the grain elevators in the terminal markets in connection with the handling, elevating, and storing of grain. The lack of knowledge on the subject and the absence of definite control methods have resulted in extensive losses to life, grain, and property.

The investigations of the Bureau of Chemistry relating to plant dust explosions and fires have been very definitely conducted along three distinct lines: (1) Dust explosions that occur during the handling and milling of grain in elevators and industrial plants; (2) fires and explosions in grain thrashing machines; and (3) fires in cotton gins and cotton-oil mills. Very definite results have been obtained in the investigations of explosions and fires in grain-thrashing machines and effective control methods have been developed by the bureau. In the Pacific Northwest, including the agricultural sections of eastern Washington, northern Idaho, and northeastern Oregon, these explosions have been controlled by (1) the installation of specially designed dust-collecting fans for the removal of the explosive smut dust and (2) the application of grounding systems for the purpose of conducting static electricity away from the machine. One of the principal causes of these thrasher explosions appears to be the ignition of the dust and air mixture by static electric sparks produced during thrashing operations. The bureau has cooperated with the State fire commissioner of Washington and other State officials in special investigations to determine the efficiency of these preventive methods, and the results obtained have been sufficiently encouraging to terminate the investigational work on this phase of the subject. This part of the bureau's work has been a definite contribution to the prevention of these explosions in thrashing machines, and arrangements have been made with the extension forces of the department for the application of these preventive measures. The fans that have been designed have not only proved effective in explosion control but have also indicated their value in

cleaning the grain and preventing the wind dissemination of smut spores.

In the studies of explosions in grain-handling plants, the bureau has been able to determine a number of the causes and develop effective control methods. Special experimental work has shown that the breaking of electric lamp bulbs in dust clouds has been responsible for a number of explosions, and, in cooperation with the manufacturing companies, special equipment consisting of a vapor-proof bulb, properly guarded, has been developed and recommended. These recommendations are covered in Department Circular No. 171. It has also been found that explosions can be controlled by the use of inert gases for the prevention of flame propagation. The bureau has shown that by reduction of the oxygen content and the introduction of carbon dioxide the explosion can be confined locally and the extent minimized.

Attention has been given to the design and development of a rotor separator which can be attached to suction fans to prevent the passing on to the dust collector of any grain drawn in with the dust-laden air. A patent has been granted on the attachment and preliminary tests with a small model justify further tests under actual operating conditions.

The explosive limits indicating the amount of dust and air necessary to form an explosive mixture have been determined for a number of dusts. It appears that the various kinds of dusts have various ranges of explosibility similar to various gases. It has been determined that as small an amount as 0.02 ounce per cubic foot will form an explosive mixture of grain dust and air.

As a result of the bureau's work on the subject, the industrial commissions, safety associations, and insurance organizations of the United States and Canada have made applications of the preventive methods already developed, with the result that the importance of the problem is being well recognized and the bureau is being constantly called upon to test various kinds of dust to determine their explosibility and to suggest control methods. Recent explosions of new kinds of dust have been occurring, and the bureau has been called upon to study a series of explosions of lime-sulphur and insecticide dust being manufactured in powdered form. Special assistance has been given to the industrial commission of Wisconsin in a study of dust-control methods in grain elevators in line with efforts being made by the Canadian Government and safety organizations in the United States.

A large number of bulletins, circulars, pamphlets, leaflets, and cards have been issued by the bureau dealing with the causes of these explosions as they have been established by investigation and with control methods that have been determined by experimental work. There has been an active demand by the agricultural interests and the industries of the country for these publications, and they have been the basis of State and municipal control and supervision.

UTILIZATION OF FRUITS AND VEGETABLES.

Work on the factory production of sweet-potato sirup at Fitzgerald, Ga., was completed during the year and a report prepared for publication. This report gives all of the data developed in the

laboratory experiments and in the factory work that will be of value to anyone undertaking the production of sweet-potato sirup. In general, the results of the factory work substantiated those previously obtained in the laboratory. It was practicable to produce a clear sweet-potato sirup of excellent flavor on a small factory scale. It is believed that the process developed will provide an outlet for many of the cull and surplus sweet potatoes.

Work in the laboratory was done on the changes which occur in the sweet potato on heating, and these results were submitted for publication. Before this work was done it was well known that the sweet potato contains large quantities of an active diastase. The laboratory results show that the diastase is so well distributed throughout the sweet potato and is so closely associated with sweet-potato starch that more or less complete hydrolysis of starch results whenever sweet potatoes are cooked. The action is very rapid, and, indeed, it was found difficult to heat sweet potatoes in any way without causing some digestion of the starch through the action of the diastase. The principal carbohydrate formed was found to be maltose.

This study is believed to have value in guiding future efforts which may be made in converting surplus and cull sweet potatoes into economic products. For example, if it should be desired to convert potatoes into the dehydrated form, for use in alcohol or vinegar production, the recognition of the presence of the diastase and its action in digesting the starch upon cooking would be of great assistance in the determination of the process to be used.

Investigations to improve further methods for the utilization of cull and surplus oranges and lemons were continued at Los Angeles, Calif. The development of commercial industries utilizing much of the cull and surplus citrus fruit of California has been reported previously. Several concerns are now profitably manufacturing valuable commodities from fruit by methods resulting from these investigations. Growers of fruit can now dispose of culls at a greatly increased price. A paper on the work on orange vinegar was published during the year. Work on the crystallization of citric acid without previous precipitation as calcium citrate was completed. An investigation was made of the use of dialysis in the preparation of commercial pectin from the waste products of both oranges and lemons. The laboratory work has reached a stage where manufacture on a semicommercial scale will soon be started.

Progress was made in the investigations aimed to improve processes for the dehydration of fruits and vegetables. Dehydrated fruits and vegetables greatly superior in appearance and flavor to the old-fashioned dried products have been put on the market. It is expected that still further improvements will result from this work. The dehydration work was transferred on July 1, 1922, from Washington to Los Angeles, Calif., and combined with the laboratory which has done such excellent work on the utilization of oranges and lemons. This change enables the bureau to effect certain economies and to increase the efficiency of the work.

Work similar to that in utilizing by-products from oranges and lemons, however, should be extended to include other fruits and

vegetables. Every year there are a great many cull fruits and vegetables which are not suitable for sale as food. It is believed that great quantities of these by-products of the farm could be turned into profitable products if adequate study from a chemical technological viewpoint were made of the possibilities. There is a great field for further development in the matter of fruit juices. The bureau has already done enough work along this line to indicate that a great deal of the fruit which now goes to waste or is used with small profit to the farmer can possibly be used in the manufacture of fruit beverages, thus increasing the profits to the producer.

WORK FOR OTHER DEPARTMENTS.

The Bureau of Chemistry does a large volume of chemical and technological work for the other departments of the Government, in addition to the extensive work done for other bureaus of the Department of Agriculture. The specialists in the bureau act as consulting chemists to other departments, aiding in the solution of problems based on chemical methods. This service not only saves the Government the expense of maintaining a number of small laboratories in various departments, which in the aggregate would cost a large sum to maintain, but makes available for this work a larger staff of specialists than is elsewhere assembled. The work can be done by men who specialize much more economically and efficiently than by men who work on a great variety of products as chemists in a small laboratory are usually required to do.

The volume of work done for other departments has become so large, however, that it can now be done only at the expense of the work with which the Bureau of Chemistry is primarily concerned and for which its appropriations are made, that is, agricultural chemical investigations, the enforcement of the Federal food and drugs act, and the tea inspection act. A small appropriation is made annually to defray the cost of such work, but this sum is inadequate to meet the requests for assistance from other departments.

One of the most important lines of work is that for the Post Office Department in the application of the law relating to the fraudulent use of the mails to so-called remedies and mail-order treatments for a great variety of diseases and disorders, ranging from obesity cures to sure cures for tuberculosis or cancer. In order to apply the law to fraudulent preparations of this nature it is necessary that a chemical analysis be made of the materials and that expert testimony be furnished as to the ineffectiveness of the ingredients to alleviate or cure the diseases for which the preparations are fraudulently sold through the mails. Dealers in fraudulent cures can frequently be reached more effectively through the application of the mail-order law than the food and drugs act; in fact, effective control in this manner can be inaugurated in certain instances where the food and drugs act lacks jurisdiction. During the year the major portion of the time of the staff of the drug division of the bureau was devoted to the analysis of samples of these products and to furnishing assistance to the officials of the Post Office Department in conducting hearings and preparing and prosecuting court cases.

A large number of samples of foods and drugs were analyzed for the War and Navy Departments to see that they complied with the

standards under which they were purchased. This work is carried on not only in the various laboratories in Washington but also in the laboratories of the branch stations located in the leading trade centers throughout the country. Other work included examination of a great variety of samples for the different Government departments and independent establishments.

Assistance has been given to the congressional Joint Committee on Printing in the preparation of paper specifications, and to the Public Printer in establishing a testing section at the Government Printing Office for testing paper and other supplies. About 50 samples of bookbinding leathers were examined for the Government Printing Office to assist in checking deliveries against standard samples, drawing specifications, and making awards. Information was supplied to the Navy Department on proposed specifications for pneumatic and hydraulic leathers of high heat resistance. A statement on the composition and adulteration of leather was prepared for the Federal Trade Commission.

COLOR INVESTIGATIONS.

Investigations to aid in the development of a dye industry in the United States were continued. The practical results obtained in the discovery of processes for the manufacture of certain dye intermediates, which enable American manufacturers to make these intermediates in competition with German manufacturers who at one time monopolized their manufacture, were previously reported.

Indigo.—Indigo is one of the most important dyes manufactured in the United States. The process at present in use in this country has been not altogether satisfactory, and an investigation was undertaken with a view of substituting an alternative method for the preparation of this dye. A survey was made of the entire process and the results obtained indicate that indigo of good quality can be obtained at a somewhat lower price than is possible by the method now in vogue. Two papers on this work were published.

Indigo derivative from cymene.—A new dye similar in dyeing properties to indigo has been made from cymene—a waste product obtained in the preparation of paper pulp from certain resinous wood. A paper giving a detailed description for making this dye was published.

Anthraquinone from anthracene.—Anthraquinone is an intermediate used in the preparation of the valuable dye "alizarin." A relatively simple method was worked out for the making of anthraquinone from anthracene, one of the "crudes" obtained from coal tar, using the oxygen of the air instead of the rather expensive chemicals heretofore used. A public-service patent was granted on this process.

Vital red.—Although this dye is used in only small amounts, it is nevertheless of tremendous importance both in time of peace and in war. It is used by physicians in testing blood volume. The medical men have been unable to secure the dye in this country in satisfactory quality and accordingly a complete study of the method of preparation was undertaken. Several batches have already been prepared and submitted to expert medical investigators for examination. Work on this dye is being continued.

Photosensitizing dyes.—These dyes are used in photographic work, especially in aerial and astronomical photography. Improvements have been made in the preparation of a number of these dyes. A new method for making the dye known as “dicyanine” was discovered and a public-service patent applied for.

New analytical method.—The greatest need of the dye industry at the present time is for better methods of analyzing dyes and intermediates used in preparing them in order to produce dyes that will give uniform results. Work along this line was undertaken and a new method devised for the detection of “H” acid, a substance used very extensively in the dye industry. A full description of the method was published in one of the technical journals.

Physical chemical measurements.—Inasmuch as no reliable data were available on certain physical constants of the more important intermediates, work was undertaken for their determination. Vapor pressure measurements were made on naphthalene, anthracene, phenanthrene, and anthraquinone. The solubility of certain naphthalene sulphonic acids which are used in the dye industry was determined.

Standardization of biological stains.—A chemical study of the pre-war German biological stains and of the American product which is being manufactured to take their place, with rather unsatisfactory results in some instances, was undertaken. Inasmuch as these stains are used by bacteriologists, pathologists, physicians, and veterinarians in the study and identification of disease-producing organisms, it is of the greatest importance that only stains of uniform and constant composition be used for such work. This problem is of importance to the country, inasmuch as the health of the citizens and also the health of the live stock and plant crops of the country are vitally concerned. In view of the rather extensive nature of the problem, only the most important of the biological stains were investigated during the year. It was found that certain American stains were equal to the pre-war German stains, whereas others were unsatisfactory. The methods for preparing these stains are being thoroughly investigated and an effort made to standardize the methods of preparation so as to obtain a uniform product. This work is being pushed rapidly and the possibility of devising quick and accurate analytical control methods is being investigated.

Production of thymol from cymene.—Thymol is a drug that is used extensively as an antiseptic, but more especially as a specific against the hookworm disease. It is now imported from India, where it is found in the seed of one of the plants indigenous to that country. It was discovered, however, that synthetic thymol identical with the natural product can be obtained from cymene, a waste product in the paper industry. It is estimated that 2,000,000 gallons of cymene are wasted annually in this country and Canada. Thymol is now sold for \$4.50 per pound, whereas it is estimated that the synthetic product can be made for about \$2.50 per pound. A public-service patent on the process has been applied for. Several chemical manufacturers have already become interested in it, and it is quite likely that this country will soon be able to produce all the thymol consumed here.

Certification of dyes.—The work on the certification of dyes is done in the analytical section of the laboratory. This is part of the food and drug enforcement work. A certain limited number of dyes are

permitted to be used for coloring food products. The dyes are tested for arsenic and other injurious and poisonous substances that may be there, and if found present the dye is rejected. Determinations on the strength of the dye are also made. If the sample submitted comes up to standard a certificate for the particular batch of dye from which the sample was taken is issued. From 8,000 to 9,000 pounds of dyes are thus certified every month.

ENFORCEMENT OF REGULATORY STATUTES.

THE FOOD AND DRUGS ACT.

The magnitude of the food industry is indicated by the latest statistics of the Bureau of the Census of certain manufacturing industries which show that in 1919, 67,453 establishments were engaged in the manufacture of food products. The annual value of the products of these establishments was \$13,391,914,000. These figures cover only manufactured foods and do not take into account the great volume of commerce in nonmanufactured foods, such as milk, fresh fish, raw oysters, wheat, corn, oats, all fresh fruits and vegetables, and the like, to which the food and drugs act also applies when they are shipped within the jurisdiction of this act. Imported food products, which also come under the provision of this act, were valued during the calendar year 1921 at \$672,975,456. The annual cost of enforcing the Federal food and drugs act is less than one hundredth of 1 per cent of the value of the foreign and domestic products coming within its jurisdiction.

PROJECT SYSTEM.

The food and drugs act is corrective rather than punitive. Its effective enforcement is of advantage primarily to consumers but also to the great majority of those engaged in the food industry who do an honest business since it eliminates competition with adulterated, debased products and promotes fair trading.

Owing to the magnitude of the food and drug industries, the extensive territory to be covered, and the great variety of products to which the food and drugs act applies, it is possible to maintain an effective supervision of interstate and foreign commerce in these products with a small organization only by having every unit of the organization working in unison towards a common end and in accordance with a definitely planned schedule. This is accomplished by preparing before the beginning of each fiscal year a schedule of projects which includes all the important lines of work to receive attention during the year, and a definite plan of attack for each line, showing the time the work is to be done and the part to be done by each unit of the organization.

Before laying out a campaign to correct any particular trade abuse that violates the provisions of the food and drugs act, a careful survey of the industry involved, to determine the extent of the violation and its effect on consumers and the trade, is made by the units of the field force that are in the best position to do it effectively, and a preliminary plan of action is prepared. This plan of action is considered by the administrative officers of the bureau and

by the staff specialists in the light of the knowledge developed by the survey and investigations in the staff laboratories. The value of the work to be done and of the evidence to be obtained is determined and a definite plan of action approved. It then becomes a part of the schedule of work for the year and the districts proceed to carry it into effect.

The success of this plan of control involves a proper understanding between the administrative officers in the field and those in Washington. This is brought about chiefly by the special or staff laboratories and offices of the bureau whose services are of a liaison character. The plan is thoroughly cooperative and contemplates a proper articulation of every agency whose work has any bearing on any one of the schedules.

COOPERATION WITH STATE AND CITY GOVERNMENTS.

The work of the Federal Government in regulating interstate and foreign commerce in foods and drugs supplements but does not displace the work of State and city governments in regulating the manufacture and sale of these products within their respective jurisdictions. A State officer in Ohio can not reach a manufacturer in New York who ships adulterated food into that State, but such a manufacturer may be reached through the operation of the Federal food and drugs act. While the fields of operation of the Federal, State, and city food and drug control officials are separate and distinct, they are working for the same general objects and upon the same kinds of products, so they have many problems in common. The efficiency of the work can be promoted and its cost kept at the minimum through close cooperation among all food and drug officials. There is maintained in the Bureau of Chemistry an office of cooperation, the main function of which is to promote effective teamwork in the enforcement of food and drug laws, especially through the exchange of information regarding methods of analysis and inspection, commercial practices, standards, violations of law, and the like.

Gratifying results have been obtained in the increased correspondence and requests for information, as well as by the receipt of information from those officials in various ways. Very satisfactory reports have been received from the field forces as to the cooperation being received from the various State and city departments, and especially from several States and cities where heretofore the cooperation had been relatively undeveloped. In addition to the maintenance of cooperation already developed among State officials, an attempt has been made to secure more active cooperation on the part of municipal officials engaged in food and drug law enforcement. Results so far have been very encouraging, and it is the plan to prosecute work along these lines during the present fiscal year.

WORK OF THE STAFF LABORATORIES.

The work of the staff laboratories during the year has been directed in accordance with the project scheme of handling regulatory problems. These laboratories manned with specialists study the many problems involved in applying the food and drugs act to specific products. They work out methods for detecting adulteration, collect data

regarding processes of manufacture, study the composition of foods and of materials that enter into the manufacture of food, review evidence in cases, furnish expert testimony, and in general develop information to aid the administrative offices of the bureau in arriving at decisions and in formulating policies and to aid the field offices in carrying out their regulatory projects.

The following investigations by certain of the staff laboratories indicate some of the more important problems under consideration and illustrate the variety and extent of the work.

FOOD-CONTROL INVESTIGATIONS.

The food-control laboratory, which, as its name indicates, supervises the chemical work on foods, also conducts investigations necessary for effective food control not provided for in other staff laboratories. The hydrogen-ion concentration of egg whites is being studied with the view of determining its effect on the whipping qualities of the different egg-white preparations. Methods of analysis have been worked out in preparation for a study of the composition of alimentary pastes and the raw materials used in their manufacture. In connection with the investigation of alimentary pastes, samples of whole eggs, egg yolks, and egg albumen in the dried condition were collected and analyzed in order to assist in determining the nature of the egg material used in egg noodles. A method for detecting remade milk has been published. All available data on flour grades and flour standards were assembled and submitted to the joint committee on definitions and standards for consideration in formulating standards. Experimental batches of prepared mustard have been analyzed in a study of mustard products with the view of preparing recommendations for the labeling of mustard products containing hulls and turmeric. Numerous analyses of authentic samples of cocoa nibs were made and the data submitted to the joint committee on definitions and standards for a revision of the cocoa and chocolate standards.

MICROBIOLOGICAL INVESTIGATIONS.

The microbiological laboratory investigates food problems in which bacteria and other microorganisms are involved. This includes the examination of samples taken under the food and drugs act to detect adulteration, contamination, and pollution. The laboratory controls the microbiological examination of foods and drugs in the three field districts of the bureau. During the year special attention was given to the examination of water for pollution, salmon for spoilage, and canned foods, particularly spinach, for *Bacillus botulinus*.

A boric-acid canning powder was investigated to determine its value and fitness for use in canning. In the practical canning experiments the use of the powder for acid products was shown to be an unnecessary and wasteful practice, since material packed without the powder kept as well as that packed with it. Its use with the more or less neutral vegetables showed that the powder plus the inadequate heating recommended was not sufficient to preserve the materials or to prevent the production of toxin in them by *B. botulinus*. As the

result of the investigation a circular has been published on "Some experiments with a boric-acid canning powder."

In the investigation of the control of cream and butter further work was done for the purpose of correlating the microscopic count of oidia and yeasts with the physical condition of the cream used in manufacture. These investigations clearly show that a general correlation can be established between low counts of these organisms in butter and the use of good cream and between comparatively high counts and the use of generally old cream, but the methods used in manufacture destroy the quantitative value of such counts in estimating the relative age or relative deterioration of the different samples. It is therefore perfectly possible by microscopic examination to show that old cream has been used, although it is not possible to determine how bad the sample of old cream was before manufacture.

The results of this investigation were published during the year in papers entitled "Determination of yeasts and oidia in high-grade experimental butter," "The volatile acids and the volatile oxidizable substances of cream and experimental butter," "Creamery inspection data," and "Determination of yeasts and oidia in cream and butter."

The investigation of salmon canning has furnished an adequate experimental basis for correlating the texture and odor of the fish as found in the commercially canned product with the condition of the fish before canning. By this work, in which experimental packs of fish in known condition were prepared, a basis has been furnished for satisfactory testimony in court with reference to this product. No other means would have given the adequate information obtained in this manner. The results have been published in papers entitled "Decomposition of 'feedy' salmon," "A comparative study of spoilage in salmon," and "The sources and characteristics of the bacteria in decomposing salmon."

Work is under way on condensed milk, to develop a method of examination of the finished product which will reveal the condition of the raw milk as received at the condensery. The application of such a method will make it possible to regulate traffic in condensed milk made from raw milk of insanitary quality.

In connection with the study of molds, their activity as fermenting agents in certain food products has been a subject of investigation over a period of years. One of the products studied has been soy sauce, which is produced by the fermentation of soy beans and wheat, using various strains of *Aspergillus* belonging to the *flavus-oryzæ* group as the principal agent of fermentation. In this work the bureau had the voluntary assistance for six months of Dr. Kokichi Oshima, a Japanese student from Sapporo, Japan, who submitted at the close of his work two papers. One of them has been published under the title, "Promising development of soybean sauce (studies on the protease of the *Aspergillus oryzæ-flavus* group and its rôle in shoyu brewing)." The other, concerning the diastatic activity of the same group of organisms, is in course of publication.

A study has been made of the bacteriology of dried eggs and the correlation of the bacteriological condition of the dried product with the character of the materials used in manufacture. In gen-

eral, the physical results of the experimental work show that eggs in perfect condition before drying produce a product entirely free from objectionable odors, that the spray process will remove much of the objectionable odor from eggs which would be rejected if examined in fresh condition, and that the spray process does not remove the objectionable odor from eggs which were completely rotten. The difficulty involved, therefore, covers eggs which have reached the stage of being clearly objectionable without having become positively putrid. Further investigation should give a valuable contribution to the enforcement of the food and drugs act against dried products.

Cultural studies of *Penicillium* and *Aspergillus* and species of related genera were continued, and a stock of cultures maintained. This collection is of great value in undertaking the identification of microorganisms occurring in the course of work with food products and in answering inquiries from laboratories throughout the world.

Work on the classification of the bacteria occurring in food products was continued and a study made of the paratyphoid-enteritidis group of bacteria. This group is believed to be responsible for the majority of the outbreaks of food poisoning which are popularly designated "ptomaine poisoning" and are characterized by acute intestinal distress, accompanied by nausea, vomiting, and purging. To obtain information upon this subject, a careful survey of a series of these cultures has been made, followed by a series of experiments with foodstuffs under the conditions ordinarily occurring during the handling of food in the household. These results are embodied in a paper entitled "Development of the paratyphoid-enteritidis group in various foodstuffs," which has been prepared for publication.

A comparative study of the floras of spoiled canned foods was continued. Special attention was given to a study of botulism, since poisoning of this character in this country has been almost entirely due to canned foods. In the course of the year several poisoning cases due to canned spinach have occurred, involving a continuation of the study of this product. Extensive work of a regulatory character was accompanied by a detailed experimental study of the possibilities of poisoning due to spinach.

In general, the work was confirmatory of the work done in the preceding year with this same product, which has recently been published as "Observations on *Bacillus botulinus* infection of canned spinach." The conclusion seems to be legitimate that a scrupulous examination of cans of spinach before opening and at the time of opening would eliminate the danger of botulism in handling this product or so nearly eliminate it as to render the chances of poisoning negligible. Experiments in the laboratory clearly show that if products which even were questionable were simply boiled after opening, there would be no danger whatsoever. The recommendation, therefore, is that a careful examination of the cans at the time of opening be made and that as a supplementary precaution, if the product passes the physical examination, it be also boiled.

Another line of investigation in connection with botulism was the incubation of a series of samples of foodstuffs in conditions simulating those occurring in the household. These investigations clearly

show that poisoning of this character might readily occur if left-over foods were kept at room temperature in pantries, storerooms, or other places sufficiently warm to permit the growth of the organism, but that in the temperature of a properly kept ice refrigerator foodstuffs, even though contaminated, would not become dangerous within a period of two or three days. This work is being prepared for publication.

MICROCHEMICAL INVESTIGATIONS.

The microchemical laboratory makes examinations and studies of food and other products involving the use of the microscope. It investigated during the year methods of grading, sampling, and examining nuts. A large number of import samples of canned and dried mushrooms have been examined for insect infestation. Studies were conducted upon decomposition in fruits with a view to arriving at criteria for judgment of this class of products under the food and drugs act. These studies included blackberries, raspberries, loganberries, peaches, and apple products. As a result of this work the bureau is in a better position to judge such products than ever before.

Studies made upon flour with a view to grading the product by microscopical means have been further extended during the past season and a modified microscopical method for examination has been devised which simplifies considerably the method as originally worked out and published.

Further studies upon methods of estimating the shell content in cocoa and chocolate products have been made and a method tentatively adopted.

Regulatory work in the examination of samples and the review and preparation of evidence in cases was continued during the year and involved principally the following food products: Tomatoes, cocoa and chocolate, egg substitutes, nuts, canned fruits, stock feeds, and jams and jellies.

CONTROL OF STOCK FEEDS.

The cattle food and grain investigation laboratory performs the services of a staff laboratory in applying the food and drugs act to stock feeds and grains. All cases involving these products are reviewed and recommendations made. Information regarding stock feed and grains is furnished the inspection districts to guide them in applying the law to adulterated and misbranded products. Work was done to determine standards and definitions for various cattle feeds, and to unify the methods of analysis used in the various laboratories of the bureau.

CONTROL OF BEVERAGES.

The water and beverage laboratory acts as a staff laboratory in the control of water, beverages, flavors, and related products. In cooperation with the stations of the eastern district, a sanitary survey was made of mineral springs located in Virginia, West Virginia, North Carolina, South Carolina, and Georgia. A paper on "Radioactivity of miscellaneous waters examined in the Bureau of Chem-

istry" is in course of publication. Much attention was given to the labeling of flavoring sirups and beverages, particularly those of the orange type.

A series of articles on "Food flavors, source, composition, and adulteration" is being published in a number of trade journals. A paper on "Relative sweetness of invert sugar" was also published. Papers on "Mineral waters of unusual composition," "Specific gravity of mineral waters by calculation," and "Studies on flavors, beverages, and related products" were presented at the annual meeting of the American Chemical Society. Other papers published during the year included "Purity of bottled spring water" and "Mineral composition of seventy city water supplies."

PHARMACOGNOSY INVESTIGATIONS.

The pharmacognosy laboratory supervises the work involved in the application of the food and drugs act to crude drugs and spices, both imported and domestic. During the year special attention was given to a campaign to eliminate excessive dirt from domestic crude drugs. An investigation showed that the shipping of dirty domestic crude drugs is a rather widespread practice and is due largely to carelessness in gathering. Excessive dirt constitutes adulteration in crude drugs shipped within the jurisdiction of the act. In some instances crude drugs were found to contain 20 per cent or more of dirt, which obviously lessens the medicinal value of the drug. Preliminary educational work was carried on and plans formulated to take such regulatory action as may be necessary to correct this abuse.

Examination was made of the usual number of imported drug plants. Several shipments were found to be incorrectly labeled as to the plant from which obtained. Special attention was given to marjoram, since new adulterants were found, especially cistus leaves, which were sometimes present up to 25 per cent or more.

The results of the researches of the pharmacognosy laboratory were published in scientific and trade journals under the following titles: "Fake saffron"; "Domestic and imported veratrum (hellebore), Veratrum viride, etc."; "Alkaloids in rhizomes and roots of ipecac"; "A report on the zamia starch situation"; "The substitution of convallaria flowers for chamomile"; "Interesting substitutes for food and drug products"; "Edible and poisonous beans of the lima type"; "Robusta coffee"; "A saponin from Agave lechuguilla Torrey"; "Volume weight determinations of crude drugs and spices"; "Microsublimation of plant products"; "Identification of crude drug substitutes"; and "A new source of santonin."

PHARMACOLOGICAL INVESTIGATIONS.

The pharmacological laboratory studies the physiological effects of certain heavy metals, toxic substances, dyes, and other materials that are sometimes found in minute quantities in foods, to develop information on which to base decisions controlling their use under the food and drugs act. A paper was prepared on habituation to and the toxicity of arsenic trioxide. Experiments were conducted to ascertain whether animals become immune to arsenic. Chronic intoxication

has also been studied. Several toxic preparations of arsenious oxide were prepared for the Biological Survey to be used in poisoning tests for the control of predatory animals. A public-service patent covering the preparations and their manufacture has been applied for. Department Bulletin No. 1023 on the action of strychnine as a rat poison has been published. Two papers have also been published dealing with the action of strychnine. A report was made covering the toxicity of a series of dyes. Studies were continued on the toxicity of fat soluble dyes.

CONTROL OF MEDICINAL PREPARATIONS.

The office of drug administration is the staff advisor in the application of the food and drugs act to pharmaceuticals and to proprietary and other preparations which are sold as remedies for disease. The director of this office is a surgeon of the United States Public Health Service detailed to this bureau for the purpose. All matters involving the adulteration or misbranding of drug products are reviewed in this office, and evidence prepared to support the Government charges in court action. Plans for the correction of such adulteration and misbranding are formulated, and a general supervision maintained of all the work relating to the control of labeling medicines under the food and drugs act.

WORK OF THE FOOD AND DRUG INSPECTION DISTRICTS.

The field force of the bureau makes factory inspections, collects and analyzes samples, holds hearings under the law, studies trade practices and in general formulates plans of attack, and carries out the policies of the department and the orders of the courts. For the purpose of maintaining a closer supervision under the food and drugs act over interstate and foreign commerce in foods and drugs it is divided into eastern, central, and western food and drug inspection districts, with headquarters, respectively, in New York, Chicago, and San Francisco. The work of each of these districts is carried on under the direction of a district chief, through stations strategically located in the leading trade centers. The stations of the eastern district are in New York, Philadelphia, Boston, Buffalo, Baltimore, Savannah, and Porto Rico; those of the central district in Chicago, St. Louis, Kansas City, Cincinnati, Minneapolis, and New Orleans; and those in the western district in San Francisco, Seattle, Los Angeles, and Denver.

SPECIAL FEATURES OF YEAR'S WORK.

The work under the food and drugs act during the year covered as usual a great variety of foods and drugs. Much work was done on a number of projects which seemed to require special attention because of conditions found to exist during the year.

Vinegar.—Attention was given to the practice of some firms of selling as cider vinegar or as apple vinegar a vinegar made from dried-apple products. The department had previously announced in food-inspection decision No. 140 that vinegar made from dried-apple products should be plainly marked to show the material from

which produced. Certain manufacturers appealed to the department to change this ruling. A public hearing was given in August, 1921, to those interested in the question. A case came up for judicial determination in the Federal court in Milwaukee, Wis., in December, 1921, with the result that the court sustained the position taken by the department. However, certain concerns continued to ship into interstate commerce vinegar misbranded in this respect, and it became necessary for the department to seize a large number of shipments in order to check the practice. Certain of these cases are still pending before the courts.

Flour.—In examining shipments of flour to see that bleached flour coming within the jurisdiction of the food and drugs act was labeled as bleached, it was found that many of the shipments to the Pacific coast contained excessive moisture and were short of the weight declared upon the labels. Seizure of numerous shipments was effected and a number of shippers were cited to hearings.

Canned spinach.—A few cases of botulism having been traced to canned spinach, special attention was given to this product during the year. The California board of health issued regulations prescribing the time and temperature at which canned spinach put up in that State should be processed. The San Francisco and Los Angeles stations made complete and systematic inspections of canneries putting up spinach, giving particular attention to the condition of raw material entering the packs, length of time held before canning, temperatures and time of processing, cut-out weights, and the like.

Tomato products.—Canned tomatoes and tomato products, such as catsup, pulp, and purée, have received the attention of all three food and drug inspection districts for several years. Where careful sorting is not employed it is possible to incorporate considerable portions of moldy or rotten tomatoes, especially in such products as pulp and purée, without detection of their presence by consumers. Reports of the work during the last fiscal year indicate, however, that a great improvement has been made in these products, and that the extensive educational and regulatory work carried on during previous years has been quite effective.

In the course of the bureau's regulatory work on canned tomatoes and tomato products it early became evident that the size and distribution of the industry was such that progress in the elimination of unsatisfactory conditions could be made only by operation under an organized plan of action. Accordingly, during the packing season of 1917 the work was first outlined on a project basis, although owing to the limited field force it was impossible to carry it on in an extensive way during that year. During succeeding seasons the inspection districts have been able to give increasingly more attention to the project. The project plan which has been followed with minor modifications consists in (1) listing all plants in each station territory; (2) pre-season or early season inspections of all plants not previously inspected, with constructive suggestions as to improvements where necessary; (3) classification of all plants according to their practices, whether good, bad, or questionable; (4) follow-up inspections during the packing season of bad and question-

able plants to determine whether unsatisfactory conditions have been corrected or still prevail; (5) collection of authentic samples of unadulterated goods for comparison purposes; (6) reporting interstate shipments from establishments believed to be manufacturing adulterated products and collection and examination of samples, followed by regulatory action.

Factory inspections are made by men especially trained for the purpose, and suggestions are freely offered to packers where it appears that corrections in their practices will improve the character of the output. Complete records of inspections and of all suggestions are made on special factory inspection report forms.

Frozen oranges.—Owing to a severe freeze in California in January, 1922, about 40 per cent of the orange crop was frozen to a degree that rendered it unfit for food. Frozen oranges may not show evidence of damage immediately after freezing, but they deteriorate gradually for several weeks and ultimately develop a dry and juiceless condition, varying in degree with the extent of frosting. Thus a shipment apparently uninjured when packed may become practically worthless by the time it reaches an eastern market. It is to the interest of the trade as a whole to keep such fruit from the market.

The State of California, in the interest of the orange industry of the State, issued drastic regulations to prevent the shipment of frozen oranges. Through the cooperative efforts of Federal and State inspectors a close watch was kept on shipments of oranges, and several shipments of the frozen fruit were seized under the Federal food and drugs act in the various sections of the United States to which they were shipped. This was made possible through the unified action of the various stations of the bureau.

Stock feed.—Work on the control of stock feeds is an important project in the three inspection districts, but particularly so in the central district, which is the chief producing section in the country. Most of the States require by law that the labels on packages of stock feeds shall show the percentage of protein, fat, crude fiber, and other substances which indicate the probable feeding value of the product. Incorrect branding in this particular is in violation of the Federal law where the product is shipped interstate. Extensive work on the part of the field force has been necessary to check this form of misbranding. Another form of adulteration to which attention was given was the addition of water and screenings to oats. Other feed products investigated include cotton seed, mixed feeds, alfalfa meal, linseed meal, barley products, and the like. Reports from the inspection districts indicate that there has been less adulteration and misbranding in feeds since the cost of feed ingredients has decreased than was prevalent when prices were high during and immediately following the war.

Chloroform.—A campaign was carried on during the year by Federal, State, and city officials to eliminate from the market decomposed chloroform put up in tins and found to be unfit for anesthesia purposes. The districts were instructed to proceed systematically with the collection and examination of chloroform in tin containers. Several seizures of the decomposed product were effected. Some of the leading manufacturers took steps to withdraw immediately from the market all of their chloroform that had

been put up in tin containers. The cause of the deterioration of the chloroform has not been definitely ascertained, but it is thought that it may be due to the tin containers. The United States Pharmacopœia specifies that chloroform shall be packed in glass.

Eggs.—Continued attention was given by all inspection districts to the shipment into interstate commerce of decomposed shell eggs. Much work has been done by the bureau in previous years to educate shippers to candle eggs and reject as near to the point of production as possible those which showed signs of deterioration or spoilage. It has been the practice for country stores to buy small lots of eggs and hold them without refrigeration for several days before shipment in order to accumulate larger lots. When the eggs reach the large centers they are candled and the shipper is paid only for the good eggs. However, the off eggs not infrequently are later sold to the retail trade and then to consumers. If the eggs are candled and the off eggs rejected by the country store, the transportation charges are saved and there is little chance that the off eggs will reach consumers. As a result of the educational work of the bureau and of State officials, a larger and larger proportion of the shell eggs are being candled before shipment. Regulatory action has been taken in those cases where shippers did not heed the warnings of the department. Several seizures have been made and a number of prosecutions instituted. The inspection work during this year indicated that there has been a marked improvement in the quality of the shell eggs shipped into interstate commerce in several sections of the country, but need for further work is indicated in other sections.

The central district has inspected the sanitary conditions and quality of eggs used in a number of plants where broken eggs are packed and frozen for use by hotels and bakers. Appropriate action will be taken in those instances where the frozen-egg products shipped into interstate commerce violate the provisions of the food and drugs act.

Fish.—The Food Administration during the war encouraged the use of fresh fish and greatly stimulated the use of this wholesome food. The Bureau of Chemistry has done much work to improve the methods of handling, packing, and shipping fresh fish so they will reach inland consuming centers in a good condition. As a result larger quantities of fresh fish are being shipped into interstate commerce each year. The eastern and central districts have given considerable attention during the year to seeing that fish shipped into interstate commerce is not contaminated or decomposed through insanitary handling, that misbranding as to the variety of fish is corrected, and that the quantity of contents of fish in package form is correctly stated. A survey has been made of the fish industry of the Great Lakes and of the Atlantic coast, particularly that of New England. Regulatory action has been taken when necessary to correct violations of the law.

Several carload shipments of spoiled canned salmon from the Pacific coast were seized in the central and eastern districts on information furnished by the western district. Fifteen thousand cases of spoiled salmon had been exported from Seattle, Wash., in 1920 to Vancouver, British Columbia, to escape seizure by the

Federal authorities. At the request of the chief of the Seattle station the food officials of Vancouver kept the salmon under surveillance. It was reshipped in 1921 to cities in the central and eastern parts of the United States. The Seattle station ascertained the destination of the cars and so advised the central and eastern inspection districts. The food officials of Tennessee rendered most valuable assistance in locating and effecting seizure of the cars of the spoiled salmon shipped to that State.

Other sea food.—Work on oysters is a major project in the eastern district where a very large proportion of the oysters consumed in the United States is produced. The central and western districts also conduct work on oysters, but the quantity of oysters produced in those districts is relatively small. The three types of violation encountered in connection with fresh oysters are pollution, adulteration with water, and short measure. Pollution of oysters may be caused by the condition of the water from which they are taken, which in some places is polluted with sewage, or from insanitary practices in shucking and handling. The most effective control of pollution from the beds from which the oysters are taken consists in making a sanitary survey of the various commercial oyster beds and permitting oysters to be taken only from beds which are not polluted. Cooperative work on the part of the Public Health Service, Federal, State, and municipal food officials has made it possible to check commerce in oysters from polluted beds. Very great improvement has been made in the sanitary conditions under which oysters are shucked and handled. The most recent reports from the eastern district show that the shipment of polluted oysters from that section has been practically abandoned, and that the practice of adulterating with water and shipping short-measure oysters has been greatly restricted, being confined largely to a few concerns against whom prosecutions are pending.

Equally effective work was done during the year in checking the shipment of scallops adulterated with water. Large quantities of scallops are shipped from North Carolina to the eastern cities. Through a process of soaking in fresh water the scallops are made to absorb water and so increase in bulk. Through the cooperative efforts of the eastern inspection district and the North Carolina Fisheries Commission this practice has been practically discontinued.

Attention was given during the year to controlling the shipment of short-weight and misgraded crab meat. This industry is centered around Chesapeake Bay and its tributaries. A survey showed that sanitary conditions in the packing houses are good, but that keen competition and relatively high prices of the product led a number of shippers to pack short-weight cans and to misgrade the product. As a result of work by the eastern district, which led to some prosecutions, a marked improvement was noted during the year in this industry.

Jams and jellies.—Considerable attention was given during the year by all inspection districts and by a staff laboratory in Washington to jams and jellies and especially to the use of added pectin. By the use of added pectin and water it is possible to make a relatively large quantity of jelly with a comparatively small quantity

of fruit. The practice of selling jams and jellies made with added pectin and a small quantity of fruit in competition with products in which fruit is the chief ingredient has to a considerable extent demoralized the trade and checked the sale of true jams and jellies. Progress has been made, but additional work is necessary to control this practice.

Salad oils.—Much work was done during the year to prevent the adulteration and misbranding of vegetable salad oils, especially in and about New York. A number of dealers have persistently mixed olive oil with cheaper vegetable oils and sold the mixture as olive oil. There has also been a widespread practice of selling short-volume oils. These practices were materially checked during the year by a campaign conducted by the eastern district. Eighty-seven criminal prosecutions were instituted and 160 seizures effected.

Apples.—Through the cooperative efforts of the eastern district and the New York apple inspection service the shipment of apples from New York misbranded as to grade was checked. The New York law requires that apples in barrels be labeled as to grade. Some shippers were found to be shipping apples into interstate commerce misbranded as to grade.

Quantity of contents.—The food and drugs act requires that all food in package form shipped within its jurisdiction shall bear on the labels of the packages a plain and conspicuous statement of the quantity of contents. All the inspection districts performed much work both along educational lines to bring to the attention of shippers, particularly small shippers of fruits and vegetables, this requirement of the law, and along regulatory lines in a great variety of food products to check misbranding as to quantity of contents. Improvements were effected during the year in both lines of work. A bulletin on "Volume variation of bottled foods" was published.

In addition to the specific products mentioned, much work was done during the year on other food products. The following table shows the number of seizures effected and the criminal prosecutions instituted during the year:

Product.	Prosecutions.	Seizures.	Total.	Product.	Prosecutions.	Seizures.	Total.
Alimentary paste.....	9	4	13	Gelatin.....	.....	3	3
Apple products.....	11	6	17	Ice cream and cones.....	6	.....	6
Beverages.....	9	6	15	Jams, preserves.....	1	11	12
Butter.....	25	9	34	Meat.....	.....	5	5
Canned vegetables.....	3	16	19	Milk, condensed.....	.....	3	3
Candy.....	11	4	15	Miscellaneous foods.....	1	7	8
Chocolate and cocoa.....	8	10	18	Molasses.....	2	2	4
Colors, food.....	.....	5	5	Mustard.....	.....	6	6
Cider.....	3	.....	3	Nuts.....	1	10	11
Drugs, crude.....	2	.....	2	Oils, salad.....	87	160	247
Eggs:	.....	.....	.....	Pie fillings.....	8	1	9
Frozen.....	1	4	5	Remedies.....	11	458	469
Shell.....	41	8	49	Sauerkraut.....	.....	4	4
Feeds.....	119	38	157	Spices.....	6	37	43
Fish, canned.....	5	34	39	Sirup.....	4	7	11
Shellfish:	.....	.....	.....	Tea.....	2	11	13
Clams.....	6	8	14	Tomato products.....	15	20	35
Crab meat.....	10	2	12	Vegetables.....	15	2	17
Oysters.....	25	2	27	Vinegar.....	42	77	119
Scallops.....	21	23	44	Water.....	3	10	13
Flavors.....	21	10	31				
Flour.....	1	27	28		560	1,133	1,693
Fruits.....	25	83	108				

IMPORTED FOOD AND DRUGS.

Under the food and drugs act inspection is maintained of foods and drugs imported into the United States. The act provides that any article of food or drug offered for entry into the United States that is adulterated or misbranded under the act, or is otherwise dangerous to the health of the people of the United States, or that is prohibited or restricted in the country in which made or from which exported, shall be refused admission to this country.

This provision of the act throws a great volume of work upon the bureau, especially in New York, through which port a large proportion of the imported foods and drugs is entered. It is impossible with the limited personnel available to examine all shipments of imported foods and drugs. Attention is therefore directed to shipments of the articles that previous examinations have indicated are most likely to be adulterated. It is highly important that all shipments of each article being inspected during a given period be examined in order that the goods of every importer may be handled uniformly. It is also highly important that the work of examination be done promptly in order to prevent the accumulation of undue storage charges upon consignments. Progress was made during the year in systematizing and speeding up the work in New York, but the force available is entirely inadequate to include in the examinations all the consignments that should receive attention. The force of analysts at New York was reduced during the war, since the volume of imports was greatly lessened during that period, and appropriations for the work will not permit the force to be restored to an adequate size.

FOOD STANDARDS.

The formulating of food standards and definitions is of the greatest importance in the effective enforcement of the food and drugs act. The Bureau of Chemistry works in close cooperation with the joint committee on definitions and standards which is composed of representatives of the United States Department of Agriculture, the Association of Official Agricultural Chemists, and the Association of American Dairy, Food, and Drug Officials. During the fiscal year 1922 standards and definitions were adopted by the joint committee for the following food products: Breads, cocoa products, butter, ginger ale and ginger-ale flavor, and evaporated milk.

THE TEA INSPECTION ACT.

Tea is subject to both the food and drugs act and the tea inspection act. All teas imported into the United States are inspected at time of entry and only those teas which come up to the United States standard, both as to purity and quality, are admitted. A larger percentage of tea than usual was rejected during the fiscal year ending June 30, 1922. The rejections for quality were due mainly to damaged teas, and the rejections for purity were due to impurities in certain China green teas offered for entry during the last six months of the year.

Eleven seizures were effected and two prosecutions instituted under the food and drugs act for the shipment into interstate commerce of tea in violation of that act.

